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A ROBUST WATERMARKING METHOD FOR HIGH QUALITY IMAGE

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ABSTRACT

In this paper, we propose a new image watermarking method for copyright protection. This method is a block-based approach in spatial domain. In addition to the perceptual invisibility and robustness, image quality is also considered during the embedding procedure. Block activity is calculated to embed watermark. Watermark strength and the spread of the signal into a block are controlled by the block activity measurement. Experimental results show that the proposed method is suitable for the high quality image.

INTRODUCTION

The proliferation of digital image manipulation and Internet has created a pressing need for the protection of copyright ownership in high quality multimedia content. A number of robust watermarking algorithms for images have been developed until recently. Watermarking methods in the spatial domain have advantage over other complex methods in the transform domain for its fast and simple watermarking procedure. Previous works in the spatial domain include least significant bit (LSB) coding such as [1][2], statistical methods by Bender *et al.*[3] and Nikolaidis *et al.*[4] and block-based methods such as [5][6]. Most of the previous works in the spatial domain are vulnerable to attacks. Also, the efforts to minimize the image quality degradation were not shown in the paper yet as their main concern were on the perceptual invisibility and robustness.

Hence, in this paper, we propose a quality-controlled watermark embedding method that is robust to major image processing such as compression, cropping, scaling and rotation. The spread, the amount of image modification and watermark strength will be derived from a block activity measurement. To improve robustness against geometrical attack, a border-searching method is also proposed for further improvement.

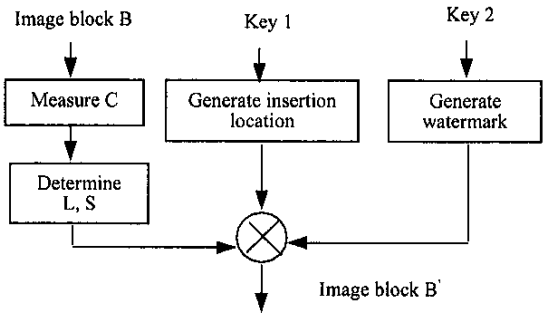

Fig.1. Embedding Procedure

WATERMARKING IN HIGH QUALITY IMAGES

To embed a watermark into high quality images, the image quality degradation should be limited to the minimum so that the information in the image can be preserved. As some users may want to produce extract information out of the given image, image quality control should be considered together with other aspects when we design a watermarking method. We have assumed that the geometrical attacks such as cropping, scaling, and rotation that will not degrade image quality. Though we don't expect to have high compression ratio, still the proposed method should endure JPEG compression with Q=70% at least.

EMBEDDING METHOD

The presented method is a block-based, spatial domain operation. One bit information will be embedded into each n x n block. Watermark strength and degree of signal spread will be determined by block activity measurement.

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The idea is that where image has high pixel value variation, we could cast strong and widespread signal while where image is simple or monotone, weak and narrow-spread signal. Instead of using the standard deviation for this measure as used in [6], we define block activity as follows:

$$C(i,j) = \sum_{blocks} \{(d_{-x} + d_{+x})|_{dir} + (d_{-y} + d_{+y})|_{dir}\} \qquad (1)$$

where,

$C(i,j)$: activity of block (i,j)
d_{-a} : difference between the current and the neighbor pixel at –a direction
d_{+a} : difference between the current and neighbor pixel at +a direction
$(d_{-a} + d_{+a})|_{dir}$: add absolute values of d_{-a} and d_{+a} only if they have different sign and zero otherwise

Once we calculate the $C(i,j)$, the watermark strength $L(i,j)$ is determined as $C(i,j)/p$. We used p to normalize watermark strength in 0~10. We define spread S that is the number of pixel pairs to be modified within a block. S is defined as follows :

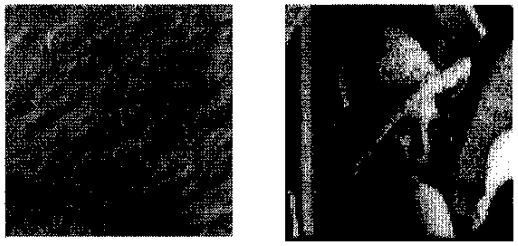
$$S(i,j) = \frac{C(i,j)}{N \cdot q} \qquad (2)$$

N is the nubmer of pixels in a block and q is the value used to normalize spread. The embedding procedure is as following. After calculating block activity, S(i,j) pairs of pixels are selected using pseudo-random number generator with a key. Each pixel in a pair is assigned into set A and set B, respectively. To embed '1' in the pixels of set A, watermark strength L is added and to embed '0', L is subtracted to the pixel value. For set B, the embedding is done in the reverse way. Figure 1 shows the block diagram of the insertion procedure.

To extract the watermark, L, S, key, and the sum of the modified pixels of each block should be provided.

IMPLEMENTATION AND RESULTS

Figure 2 shows the result of watermark embedding with the block activity measurement approach. We cast zero value instead of real modified pixel value to visualize the spread of the watermark. The image (a) is simpler compared to (b) and hence shows small spread while (b) shows reasonable amount of signal spread. The proposed method survived JPEG compression(Q=70%) with minimum PSNR degradation.



(a) Surface of mars, 256x256 **(b) Lenna, 256x256**

Fig. 2. Results of block activity-controlled embedding

Our method can be improved by utilizing block border takes time to search right orientation using them at the extraction procedure, the watermark can still be extractable even after cropping and rotation.

CONCLUSION

The watermark strength and signal spread control using block activity measurement has shown good performance in the perceptual invisibility, robustness and also image quality control point of view. This method can be used to optimize the watermarking procedure by modifying minimum number of pixels of the original image in the spatial domain. The proposed method has shown reasonable resistance to JPEG compression and geometrical attacks.

The watermark insertion algorithm allows minimum image quality degradation comparing to the other methods. The detection procedure does not require original image.

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